FOREST ANALYSIS BRANCH

Modelling Options for Disturbance of Areas Outside of the Timber Harvesting Land Base

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Modelling Options for Disturbance Outside of the THLB

Introduction

Management objectives for forest values such as, biodiversity, wildlife habitat, visual quality and water quality are typically modelled in timber supply analysis. Meeting these objectives often means achieving desired forest conditions, such as a specified age structure or proportion of old forest. The objectives usually apply to the entire forest area within a particular management emphasis area and/or landscape unit. This forest area consists of areas that are available for timber harvesting (the "timber harvesting land base" or "THLB") as well as forested areas that are not assumed to be available for harvest (the "non-timber harvesting land base" or "non-THLB").

The role of natural disturbance (wildfire, wind, insects and disease) on the THLB is typically modelled by applying estimates of unsalvaged losses (that is, the damaged timber is modelled as a 'harvest', and a portion is assumed to be salvaged and the remainder is unmerchantable and considered unsalvaged losses). If the non-THLB is to be factored into timber supply analysis, modelling assumptions also need to be made about the role of natural disturbance in altering forest conditions.

There are many options available for modelling disturbance within the non-THLB. Currently these range from assuming no disturbance through to complex stochastic models. This paper presents some approaches for modelling disturbance, most of which have been employed in previous timber supply analysis in British Columbia. These approaches can be reviewed in analysis reports that are available on the Forest Analysis Branch web site:

http://www.for.gov.bc.ca/hts/

This document is not meant to be a comprehensive synopsis of disturbance theory and modelling. Rather, it is intended to describe a range of available modelling options and perspectives as well as generate dialogue and discussion within the provincial resource analysis community. Comments are welcome and should be submitted to:

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Modelling Options for Disturbance Outside of the THLB

1. Continuous Ageing of the Non-Timber Harvesting Land Base

Description: The non-THLB continuously ages throughout the forecast.

Modelling details: The non-THLB is included in groups or zones to which forest cover requirements are applied. The area ages like the THLB, but is not perturbed in the model for the entire analysis horizon.

Remarks: This method assumes no disturbance will occur in the non-THLB. The method may be appropriate in areas where natural disturbance events are very rare. However, natural disturbance is likely to occur in the non-THLB to some degree in most regions of the province.

Example use: Most early TSR2 analyses.

2. Static Contribution from Non-Timber Harvesting Land Base

Description: A static age class distribution in the non-THLB is maintained throughout the forecast. The age class distribution could be based on current conditions, the natural range of variation, a forecast of the effects of fire control or other relevant information.

Modelling details: At the start of the analysis period, the forest cover requirements are calculated to apply only to the THLB. This approach assumes that the non-THLB will continue to contribute to objectives based on a static age class distribution. As an example, assume that the current age distribution outside of the THLB is used as the static distribution, and that a management objective specifies that a minimum of 10 percent of the forested area must be over 250 years old. Further assume that 250-year-old stands on the non-THLB currently comprise 7 percent of the forest area. Therefore, the THLB must supply the remaining 3 percent. If the THLB covered half of the total forest area, the constraint applied in the model would be that at least 6 percent of the THLB must consist of stands at least 250 years old at any given time. The non-THLB is not explicitly included in the modelling files.

Remarks: Past disturbance history may not adequately reflect future disturbance patterns, particularly given advances in fire management. Similarly, an age class distribution projected to exist at some time in the future (e.g., one based on natural range of variation or future effects of fire control) may not appropriately represent current conditions and associated management constraints.

Example use: Kootenay Lake TSA analysis, March 2001 ("Uncertainty in biodiversity seral stage requirements," see Figure 18).

3. Uniform Age Reset on Entire Forested Non-Timber Harvesting Land Base

Description: Ages on a predetermined amount of area in the contributing non-THLB are reset to age 0 (i.e., "harvested") at each period.

Modelling details: A target amount of area to be harvested from the non-THLB is calculated in advance. The target area is calculated by assuming that each stand in the contributing non-THLB will be disturbed once during a set time period (e.g., the planning horizon). The target area disturbed per year (or per decade) is determined accordingly.

Remarks: An even-age class distribution in the non-THLB is created. Because the model is following harvesting rules, some older non-THLB may not be disturbed in the model. This method applies to the entire contributing non-THLB and does not reflect variation among natural disturbance types within the non-THLB. For example, different portions of the non-THLB will likely have different susceptibility to fire or insects depending on their natural disturbance type, age and other stand attributes.

Example use: Merritt TSA, March 2001 ("Uncertainty in the application of landscape-level biodiversity requirements," see Figure 27).

4. Age Reset by Variant in Forested Non-Timber Harvesting Land Base

Description: A pre-determined amount of area in each variant within the contributing non-THLB is reset to age 0 (i.e., "harvested") based on natural disturbance intervals published in the *Biodiversity Guidebook* (or other sources). The approach is similar to option 3 but acknowledges that the frequency of natural disturbance is unlikely to be uniform across the management unit.

Modelling details:

1. Find the estimated disturbance event return interval for each variant, using the *Biodiversity Guidebook* (e.g., 200 years for CWH in NDT2 from Table 6, page 23).
2. Determine the estimated proportion of area that would be older than the applicable old seral age using Table A4.1 and associated methods of the *Biodiversity Guidebook* (page 91) (e.g., for NDT 2 old seral is >250 years, from Table 6 of the Guidebook. Table A4.1 shows that 29 percent greater would be older than age 250 years).

3. Calculate the effective rotation age that would result from the age distribution described in step 2. For example, for CWH, the effective rotation is 250 years/(1-0.29) = 352 years.
4. Divide the contributing non-THLB area in the variant by the applicable effective rotation age to derive a minimum target area to be disturbed annually in each variant.
5. Apply the minimum forest cover requirement derived in step 2 along with the annual disturbance target derived in step 4 by variant/LU. Both the forest cover requirement and target disturbance are applied to ensure both short- and long-term disturbance objectives are achieved in the model.

Remarks: An even-aged distribution in the non-THLB for each variant is created. Because the model is following harvesting rules, some older non-THLB may not be disturbed. The method assumes that the probability of disturbance is largely independent of stand age.

Example use: Dawson Creek TSA, October 2002.

5. Ignore Seral Requirements

Description: In cases where the THLB is very small relative to the total forested area, conditions within the THLB may not be important in determining the degree to which seral stage objectives are achieved over the entire forest. In such cases, it could be assumed that conditions in the non-THLB are paramount with respect to seral requirements. Consequently, it can be assumed that the seral requirements could be ignored on the THLB. Corresponding assumptions respecting the non-THLB may vary. For example, if disturbances large enough to create conditions whereby seral requirements are not achieved, the THLB would be far too small to have a significant mitigating effect. Therefore, both natural disturbance outside the THLB and seral objectives would be ignored. To represent local or stand level reservation of old forest, which might be implemented under these conditions, higher-than-average wildlife tree patch requirements can be applied.

Modelling details: Build a model that only includes the THLB. Ignore the landscape unit/BEC requirements for landscape-level biodiversity. Use the higher WTP requirements from Table A3.2 in the *Landscape Unit Planning Guide* (i.e., the ones that assume no landscape units or landscape-level biodiversity management). These requirements can be incorporated in the analysis as area netdowns or yield curve reductions.

Remarks: This approach may be justified under unusual and extreme circumstances. It was employed in the Cassiar TSA where the THLB (200 000 hectares) comprises 5 percent of the total forested area (3.7 million hectares). The area outside the THLB was sufficiently large that all landscape-level biodiversity requirements should be met outside of the THLB. This conclusion was validated by the fact that for most landscape unit-variant combinations, the THLB contributed 10 percent or less to the overall forested area. It seemed reasonable in that case to assume that there would be no difficulty in meeting the required amount of old-seral in areas outside of the THLB, regardless of the level of natural disturbance. In addition, natural disturbance in such a large area, especially with large fires, is challenging to simulate.

Example use: Cassiar TSA base case, March 2001.

6. Ignore Contribution of Non-Timber Harvesting Land Base — assume a "representative" or proportional" distribution

Description: Apply seral objectives to the THLB only. This method assumes that seral objectives should be achieved within the THLB alone.

Modelling details: Non-THLB areas are excluded from the model. Percentage seral stage requirements are applied to the THLB only, not to the entire forested land base.

Remarks: Overall, this approach assumes that the THLB and non-THLB are largely separated spatially. That is, even though the THLB and non-THLB may share BEC variants, the non-THLB should not be considered when assessing potential relationships between seral and timber objectives on the THLB. However, some non-THLB will most likely be distributed amongst the THLB (e.g., wildlife tree patches, riparian areas). Such non-THLB with appropriate characteristics should reasonably be expected to contribute to seral objectives within the area that includes inter-mixed THLB and non-THLB. The contribution of the non-THLB may be recognized by specifically selecting non-THLB to consider in seral objectives.

Example use: Fort Nelson TSA analysis, March 2001 ("Uncertainty in the land base to which biodiversity requirements are applied," see Figure 22).

7. Age Class Recycling

Description: Cap the age class distribution at a specified age (e.g., expected maximum age that trees will reach before stand breakup) and recycle old forest to age 0.

Modelling Options for Disturbance Outside of the THLB

Modelling details: Build a group that represents old forest outside of the THLB, then transfer all area that ages beyond a certain age into this group and assign an age of zero. The approach stops the non-contributing forest from ageing perpetually, without setting up artificial age class distributions (e.g., even distribution, or the current distribution).

Remarks: This method is a crude way of simulating stand break-up or stand-level natural disturbance; it assumes that break-up or disturbance occurs in oldest stands first. Any gaps or spikes in the current age class distribution continue to flow through the age class distribution throughout the analysis horizon since they are 'recycled' to age 0 when they reach the specified age. This occasionally causes shortfalls in meeting old-seral requirements. The approach may not be applicable for NDTs 1 or 2, where disturbances occur more at the tree level.

Example use: Lakes TSA analysis, March 2001 (see Table 10, "Summary of harvest forecasts for base case and sensitivity analyses with significant effects").

8. Stochastic disturbance modelling

Description: Employing stochastic modelling implies as assumption that disturbances occur according to specified distributions in space and time. The approach recognizes that the timing and extent of a particular disturbance cannot be known in advance, but that some parameters may be known (e.g., average and variance of disturbance interval and size). The model randomly chooses from specified distributions and implements disturbances according to the chosen values. Stochastic approaches to disturbance have not been used in TSR.

Remarks: It is recognized within Forest Analysis Branch that natural disturbances are not deterministic, and that important findings will come from research into the implications of modelling disturbances using stochastic techniques. Nevertheless, a deterministic approach is still used due to its simplicity. Some research indicates that deterministic approaches can employ unrealistic assumptions (e.g., that disturbances within the THLB will follow harvest priority rules and seral stage constraints, as is implied when unsalvaged losses are deducted from a harvest forecast). Such findings will be used to improve deterministic modelling. Employing a stochastic approach requires a great deal of effort to compile information and develop the necessary distributions. Many simulation runs would

need to be done to examine the implications of random disturbance. If a stochastic approach were used, the same "seed" would have to be used for sensitivity analyses investigating uncertainties in other (non-disturbance) variables, since to do otherwise would be testing the impacts of changes in the disturbance regime as well as the variable being examined.

At this time, the perspective in Forest Analysis Branch is that, while deterministic disturbance modelling has shortcomings, stochastic decision support approaches are not sufficiently developed to justify completely replacing deterministic approaches. In addition, regular and reasonably frequent decisions based on updated forest inventory information will help incorporate disturbances into decisions. If stochastic approaches are employed to model disturbance in the non-THLB, the methods, assumptions and implications should be explained clearly and in detail.

Example use: Not currently used in TSR. Stochastic approaches to disturbance have been employed in some research projects.